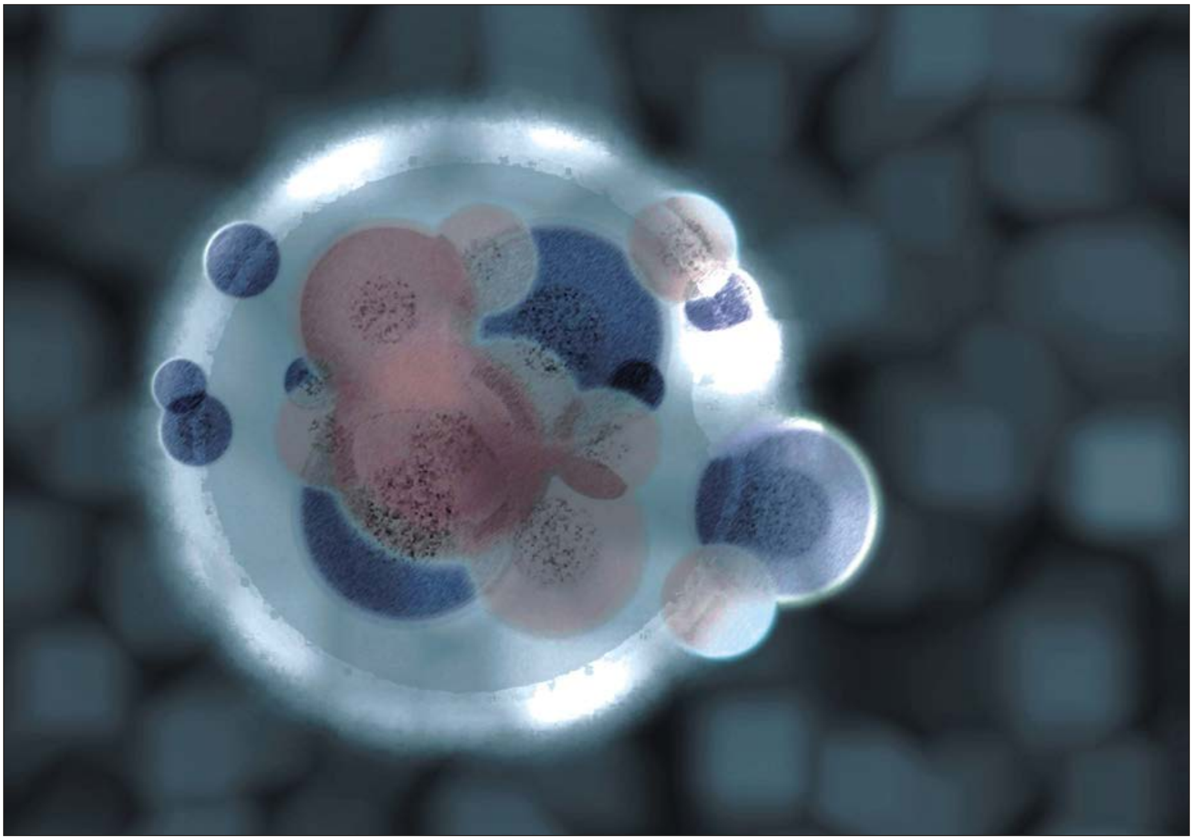

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Evaluation of Fermentation Qualities and Digestibilities of Silages Made from Sorghum and Sunflower Alone and the Mixtures of Sorghum-Sunflower

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Abstract: The objectives of this study were to evaluate fermentation qualities and digestibilities of silages prepared from sorghum (S) and sunflower (SF) alone and the mixtures of sorghum and sunflower at differing rates 75% sorghum+25% sunflower (75S25SF), 50% sorghum+50% sunflower (50S50SF) and 2% 5sorghum+75 sunflower (25S75SF)] ensiled in 120 L plastic barrel for 90 days. pH values of sorghum and the mixtures were significantly lower than that of sunflower silage ($p<0.05$). Concentrations of lactic, acetic, propionic and butyric acids were significantly greater in sunflower silage compared with sorghum silage ($p<0.05$). Silage acid concentration tended to decrease with increasing levels of sorghum in the mixtures. While concentrations of DM, OM and NDF were lower, concentrations of CP and EE were higher in sunflower than sorghum silage ($p<0.05$). Sunflower had greater DM, CP and EE but lower ADF and NDF digestibilities compared with sorghum silage ($p<0.05$). As percentage of sunflower increased, DM, CP and EE digestibilities increased but ADF and NDF digestibilities decreased in the mixtures. It has been concluded that better quality silages could be obtained by mixing sorghum and sunflower at 50% ratio.

Key words: Sorghum, sunflower, silage quality, digestibility

INTRODUCTION

Conserving feedstuffs as silage with a minimal nutrient loss is as important as their production (Çerçi *et al.*, 1997). The concentrations of dry matter, soluble sugar, protein and thus, fermentability of silage material are very critical for obtaining high quality silage (Filya, 2000). Even though sorghum silage is reach enough in carbohydrate for silage fermentation (Undersander *et al.*, 1990), digestibility of sorghum silage is low due to tannin content and structure of endosperm (Hart, 1990). On the other hand, sunflower silage has low dry matter and high cell wall contents, which negatively affects silage quality but has high concentrations of crude protein and ether extract (Gregoire, 1999).

The objectives of this study were to ensile the different mixture of sorghum and sunflower to minimize ensiling risk in addition to supplement deficient nutrient by mixing them and to evaluate silage quality and digestibility of silage.

MATERIALS AND METHODS

Sunflower (SF) and sorghum (S) harvested with a silo track at dough stage of maturity were used as silage material. The mixtures of sunflower and sorghum at differing rates of 75% sorghum+25% sunflower (75S25SF), 50% sorghum+50% sunflower (50S50SF) and 25% sorghum+75% sunflower (25S75SF)] were prepared on fresh material basis. A total of 25, 5 replicate for 5 treatments, silages were prepared in 120 L plastic barrels. Silages were packed with foot stamping and then, barrels were capped tightly with lids. After that, barrels were flipped over and buried approximately 25 cm in depth into soil to eliminate air leakage. After 90 days of incubation, silages were opened and sub-sampled for physical and chemical analysis. Physical properties such as color, smell, structure, total point quality classification of silages were determined with DLG silage evaluation guide (Alçiçek and Özkan, 1997). Fleig point was calculated as described by Kılıç (1996). After hydration of silage samples as described by Hart and Horn (1987), pH was determined with a digital pH meter. The filtrate were filtrated through Whatman 54 filter paper, centrifuged and stored at 20°C for organic acid analysis. Lactic acid and volatile fermentation products were determined by high performance liquid chromatography (Muck and Dickerson, 1988).

All of silage samples were analyzed for Dry Matter (DM), Crude Protein (CP), Ether Extract (EE) and ash

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(Bulgurlu and Ergül, 1978), Acid Detergent Fiber (ADF) and neutral detergent fiber (NDF; Van Soest and Robertson, 1979). Only crude protein content of silages was determined using wet samples. Metabolism trail was designed as completely randomized design and each treatment was randomly fed to 5 rams (Düzgüne *et al.*, 1978). Metabolism trail (feeding of animals, determination of feed intake, collection of feces and analysis) was conducted as described by Bulgurlu and Ergül (1978) using 6, 2 year old Morkaraman rams.

All data were subjected to analysis of variance using General Linear Model procedure of SAS (2005). Mean treatment differences were determined by Duncan's multiple range test with a level of statistical differences of 5% (Düzgüneş *et al.*, 1978).

RESULTS AND DISCUSSION

The concentrations of DM, OM and NDF were significantly lower in SF silage compared with those of S silage ($p<0.05$). Dry matter, OM and NDF contents linearly increased as the percentage of sorghum increased in silage prepared with a mixture of sunflower and sorghum ($p<0.05$). While ADF contents of SF and S silages were similar, it was significantly greater in the mixtures compared with sunflower and sorghum ($p<0.05$). Both CP and EE concentrations of SF silage were significantly higher than those of S and CP and EE concentrations increased in the mixtures with increasing levels of sunflower ($p<0.05$; Table 1). Similar to our study, it was reported that sunflower contained 7.1-10.7% EE and 10-12% CP on DM basis (Undersander *et al.*, 1990; Gregoire, 1999). The differences in nutrient contents of silages have reported to be due to differences in plant species and levels of plant species in the mixtures (Baxter *et al.*, 1984; Anil *et al.*, 2000; Immig and Pubst, 2002). It has been noted that the NDF and ADF concentrations decreased due to increasing level of EE in sunflower silage (Gonçalves *et al.*, 1999; Gregoire, 1999; Immig and Pubst, 2002) but increased in sorghum silages as harvest delayed (Nichols *et al.*, 1998).

All of the silages were excellent in terms of physical quality criteria such as color, smell and structure. The highest fleig point was obtained in S silage and there were significant differences among groups ($p<0.05$). SF and 25S75SF were good and sorghum alone and the other mixtures were excellent in quality based on fleig point (Table 1). It has been reported that silages with low DM content might have low fleig point and excellent silage can be obtained by increasing carbohydrate content of silage material (Iptaş and Avcioğiu, 1997). In addition, Kılıç (1986) reported a positive relationship between fleig point and silage quality.

Silage pHs significantly differed among groups ($p<0.05$). While SF silage had the highest pH value (4.35), S silage had the lowest pH value (3.88). Silage pH values decreased parallel to the decreases of sorghum levels in the mixtures. The concentrations of lactic, acetic, propionic and butyric acids were significantly different between SF and S silages ($p<0.05$). The highest lactic acid level were observed in SF silage, lactic acid level decreases parallel to the increases of sorghum levels in the mixtures ($p<0.05$). Acetic acid content of SF silage was significantly higher compared with other groups, except 75S25SF group ($p<0.05$). Silage propionic acid concentrations were negatively correlated with sorghum in mixtures ($p<0.05$). While 25S75 SF and 75S25SF groups had the lowest butyric acid levels, SF and 50S50SF groups had the highest butyric acid levels ($p<0.05$; Table 2).

It has been reported that addition of silage materials with high CP and low fermentable carbohydrate contents into mixtures (Çerçi *et al.*, 1997; Türemiş *et al.*, 1997a, b; Demirel *et al.*, 2001a, b; 2003) as well as low DM content of silage material (Kılıç, 1986; Iptaş and AvcIoğlu, 1997) can increase silage pH. Silage quality is highly related to DM content of silage material ensiled. Many studies (Tan

Table 1: Mean chemical compositions (DM %), physical characteristics and quality classification of different silages

	SF	S	25S75SF	50S50SF	75S25SF	SEM
Dry matter	21.17b	23.55a	21.66b	22.87a	23.27a	0.18
Organic matter	88.54c	91.48a	89.49b	90.44ab	90.99a	0.15
Crude protein[1]	1.74ab	1.48c	1.75ab	1.82a	1.60bc	0.03
Crude fat	11.57a	2.09e	10.35b	8.88c	5.86d	0.13
ADF	37.56d	42.30b	47.56a	45.36a	47.79a	0.45
NDF	40.97b	62.11a	47.98c	54.56b	56.85b	0.39
Smell	11	14	11	12	14	
Structure	3	3	3	3	4	
Color	2	2	2	2	2	
Total point	16	19	16	17	20	
Quality classify	Excellent	Excellent	Excellent	Excellent	Excellent	
Flieg point	72.17d	96.92a	79.88c	85.31bc	88.33b	0.07
Quality classify	Good	Excellent	Good	Excellent	Excellent	

[1] Fresh material: Values with different superscripts in the same line differ significantly ($p<0.05$)

Table 2: Mean fermentation qualities (%DM) and digestibility of different silages, (%)

Silages	SF	S	25S75SF	50S50SF	75S25SF	SEM
pH	4.35a	3.88e	4.23b	4.11c	4.01d	0.012
Lactic acid	8.75a	6.20c	7.03bc	6.31c	7.50b	0.324
Acetic acid	1.89a	1.18b	0.68c	0.84bc	1.92a	0.121
Propionic acid	1.84a	0.75c	1.86a	1.75a	1.13b	0.124
Butyric acid	0.61a	0.42b	0.19c	0.65a	0.39bc	0.009
DM digestibility	59.34a	53.83bc	57.18ab	55.47b	50.53c	0.58
OM digestibility	59.38a	57.90ab	59.05a	57.93ab	53.89b	0.63
CP digestibility	55.27a	35.57c	47.01b	49.48b	38.55c	0.64
CF digestibility	92.62a	76.19c	92.75a	91.88a	87.69b	0.28
ADF	39.19c	54.20a	54.04ab	52.51ab	55.04a	0.66
NDF	48.67b	53.15a	47.66b	48.45b	46.21b	0.71

Values with different superscripts in the same line differ significantly ($p<0.05$)

Tümer, 1996; Gregoire, 1999; Immig and Pubst, 2002) have been conducted to increase DM content of silage because low DM content of silage material causes fermentation losses and high pH values. It has been reported that there is a positive correlation between fermentation quality and organic acid levels taken place in silages and especially, acetic, propionic and butyric acids inhibit aerobic yeast and mould growth in silages (Moon, 1983).

It has been noted that silage fermentation quality did not negatively affected with increasing levels of CP in silages (Hart, 1990; Ahmad *et al.*, 1995; Demirel *et al.*, 2001a, b). Silage acetic acid contents did not differ (Çerçi *et al.*, 1997 Türemiş *et al.*, 1997a, b; Bolsen *et al.*, 1991) but propionic and butyric acid concentrations increased with increasing levels of CP in silages (Türemiş *et al.*, 1997b; Demirel *et al.*, 2001a). It has been stated that addition of 25% legumes into silage mixtures had positive effect but not at or over 50% on lactic acid production (Demirel *et al.*, 2001a,b). While addition of 25% legumes into rapidly fermentable silage material did not affect silage lactic, acetic, propionic and butyric acid levels, addition of 50% legume reduced lactic acid but increased the levels of other organic acids (Demirel *et al.*, 2003). Thus, readily fermentable carbohydrate as well as CP contents of silage materials reported to be imported for lactic acid production (Kılıç, 1986; Çerçi *et al.*, 1997; Filya, 2000).

Whereas digestibilities of DM, CP and EE were higher digestibilities of ADF and NDF were lower in SF silages compared with S silages ($p<0.05$) but OM digestibility were similar between SF and S silages. Dry matter, OM and ADF digestibilities did not significantly differ between S and mix silages. Crude protein, except 75S25SF silage and EE digestibilities of S silage were less than those of all mixtures ($p<0.05$). On the other hand, S silage had greater NDF digestibility compared with all of mixtures ($p<0.05$). Digestibilities of EE and CP increased with increasing levels of sunflower in the mixtures.

Starch and cell wall contents of feedstuffs have a great impact on digestibility (Meeske *et al.*, 2000). Increases in starch content and decreases in cell wall content of feedstuffs increase feed value (Hart, 1990) and level of NDF digestibility reported to be an important criteria for feed quality (Bal *et al.*, 1997). Balancing stalk/grain ratio (Hart, 1990) and mixing with legume to increase protein content (Baxter *et al.*, 1984) have been recommended to increase digestibility and nutrient value of sorghum. It has been reported that reduction in digestibility of sunflower due to high fiber content compensated with high oil content (Gregoire, 1999). Thus, feed efficiency of animal fed sunflower was greater than animal fed sorghum (De Azambuja Ribeiro *et al.*, 2002). Addition of sunflower into corn silage reduced DM digestibility by increasing cell wall content, but increased CP digestibility by increasing CP content of mixture (Nocek and Russell, 1988). Meeske *et al.* (2000) reported that KM digestibility was not affected by reduced NDF digestibility but Valdez *et al.* (1988 a, b) stated that reduction in KM and OM digestibility was caused by an increase in ADF and NDF contents or decrease in ADF and NDF digestibilities of silage.

In conclusion, although high quality silage can be made from sunflower harvested at dough stage of maturity, mixing sorghum and sunflower at the rates of 50/50 or 75/25%, respectively, may prevent any undesirable effects on fermentation quality and digestibility and also improve silage quality and digestibility of silage.

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